Asymmetric impacts on Mars' polar vortices from the 2018 Global Dust Storm

Conference or Workshop Item

Asymmetric impacts on Mars' polar vortices from the 2018 Global Dust Storm

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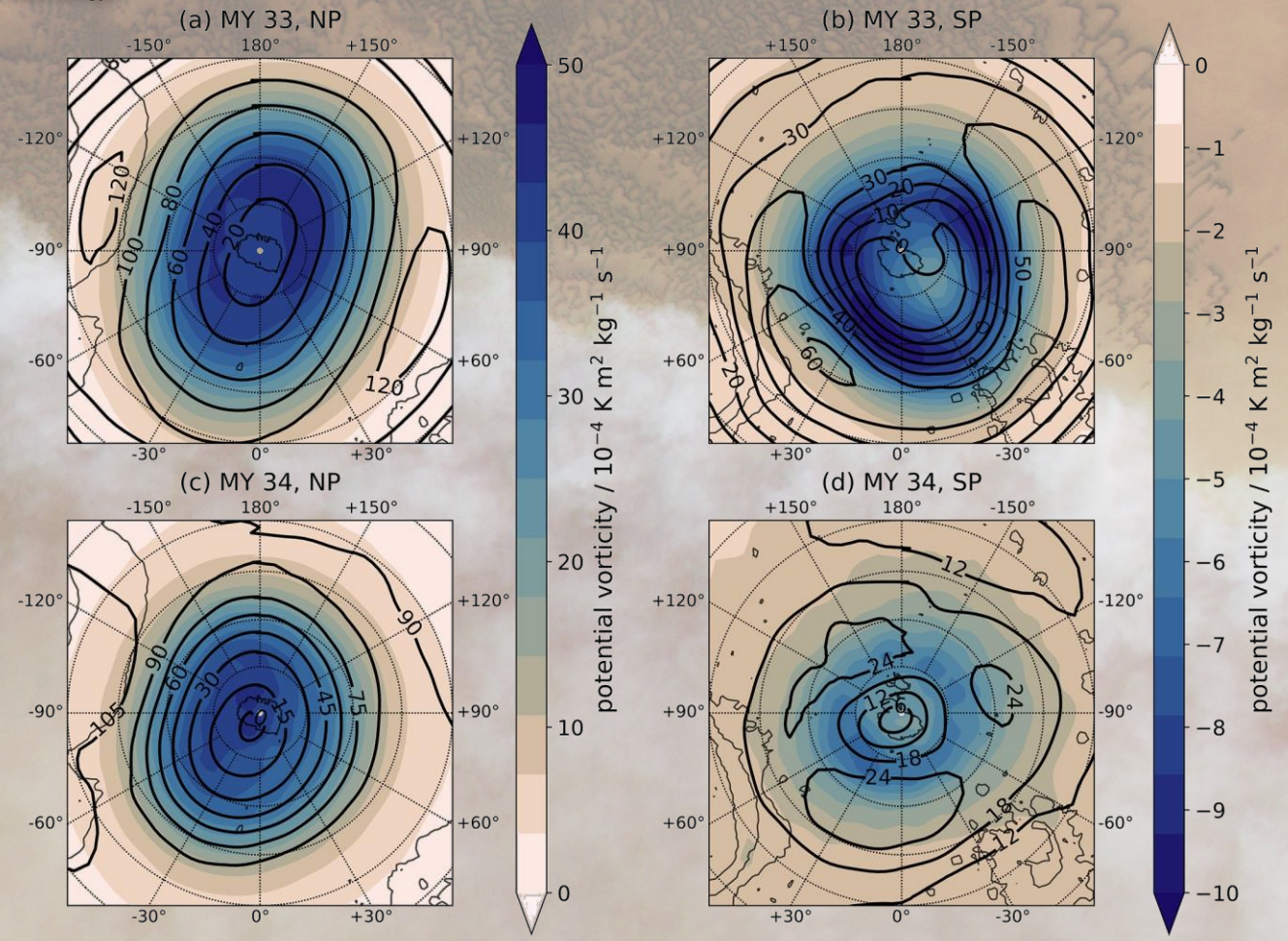

The 2018 Global Dust Storm had significant and asymmetrical impacts on the morphology and intensity of Mars' two polar vortices

The southern vortex was substantially diminished while the northern vortex remained robust, but both were reduced in ellipticity

These vortex changes enhance transport into Mars' southern (but not northern) polar region and modify longitudinal transport patterns

PAPER LINK

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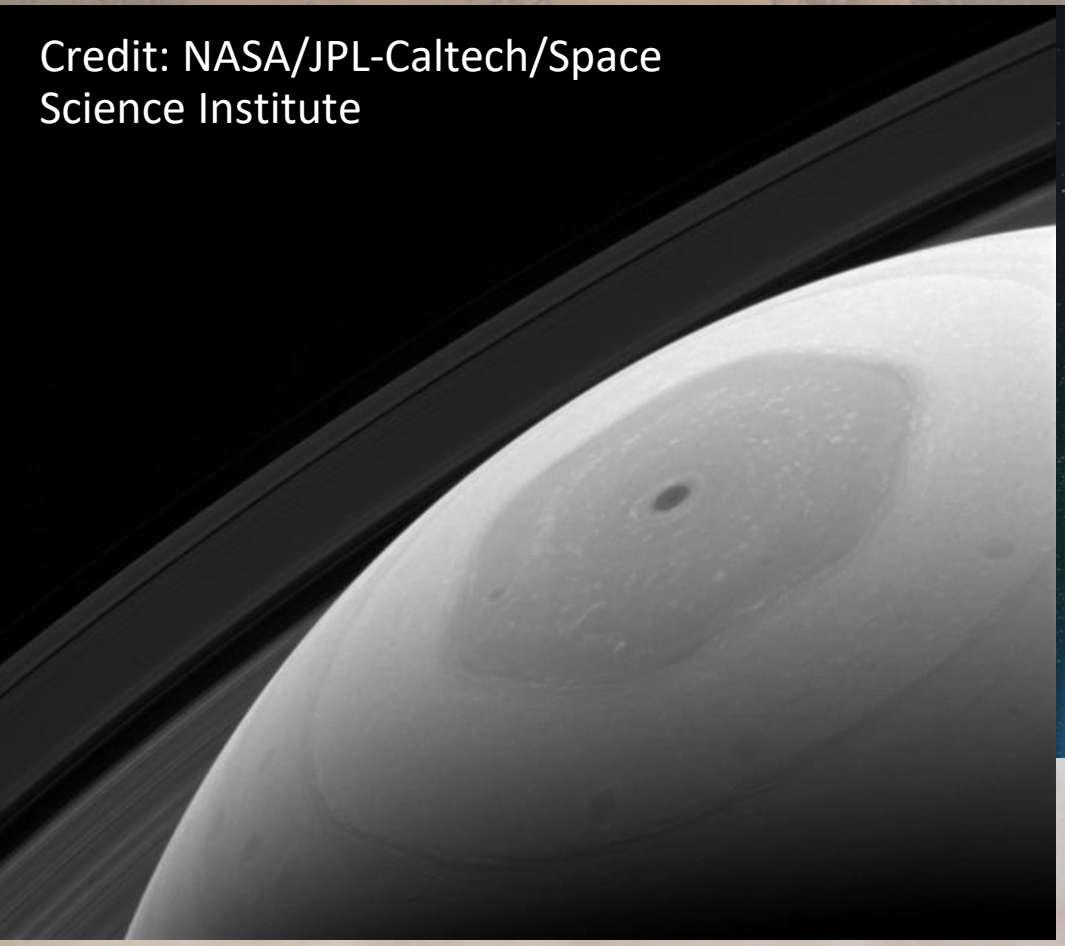
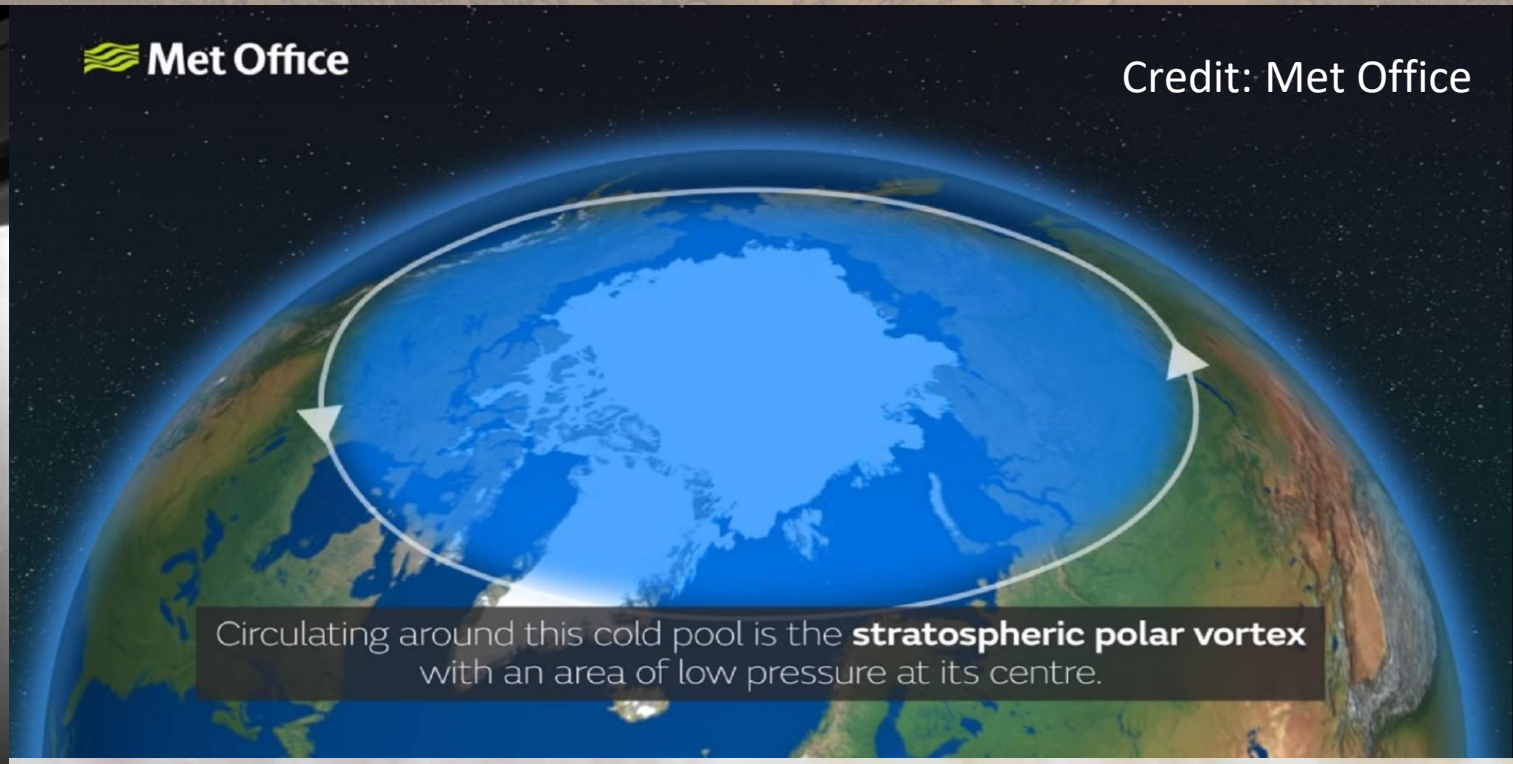
Polar vortices



Credit: NASA/JPL-Caltech/Space Science Institute



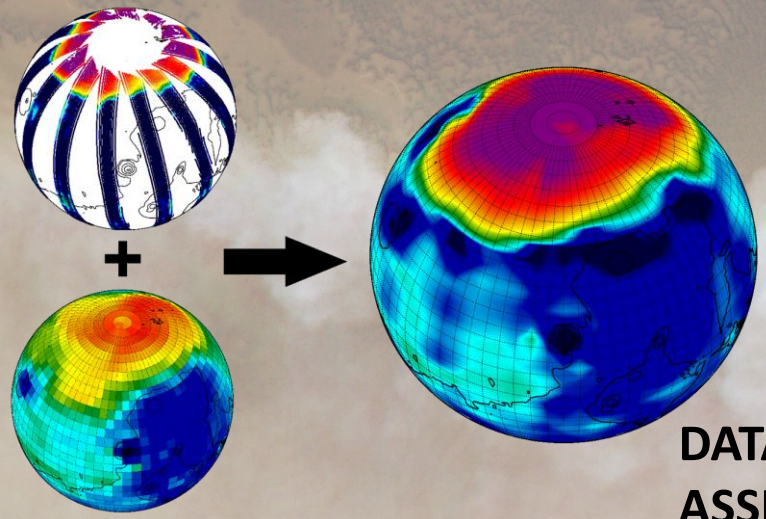
Credit: Met Office

- Common feature of planetary atmospheres
- Regions of cold, isolated air over winter pole circumscribed by powerful westerly wind jet
- Mars has characteristically elliptical vortices

Background: ESA/DLR/FU Berlin

Methods

OBSERVATIONS: Mars Climate Sounder (MRO/MCS) + Atmospheric Chemistry Suite (TGO/ACS)



DATA ASSIMILATION

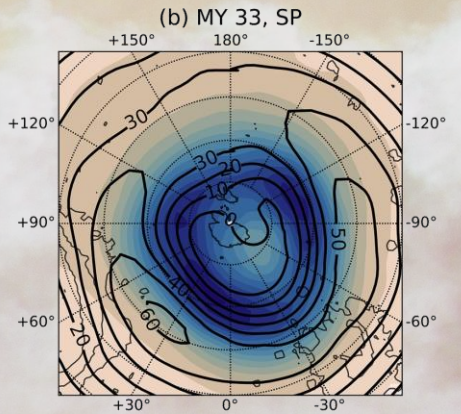
MODEL: Mars Global Climate Model (MGCM)

2018 GLOBAL DUST STORM

- Mars Year (MY) 34
- Latitudinal extent: ~40 N to ~60 S
- Lasted several months
- Occurred at Mars equinox (transition from southern autumn/winter to southern spring/summer
- Compared to MY 33, a “typical” year on Mars (no Global Dust Storm)

POTENTIAL VORTICITY (PV)

- Conserved dynamical/thermodynamic quantity
- Useful tracer for polar vortex location and intensity
- Greater value → more intense polar vortex



Background: ESA/DLR/FU Berlin

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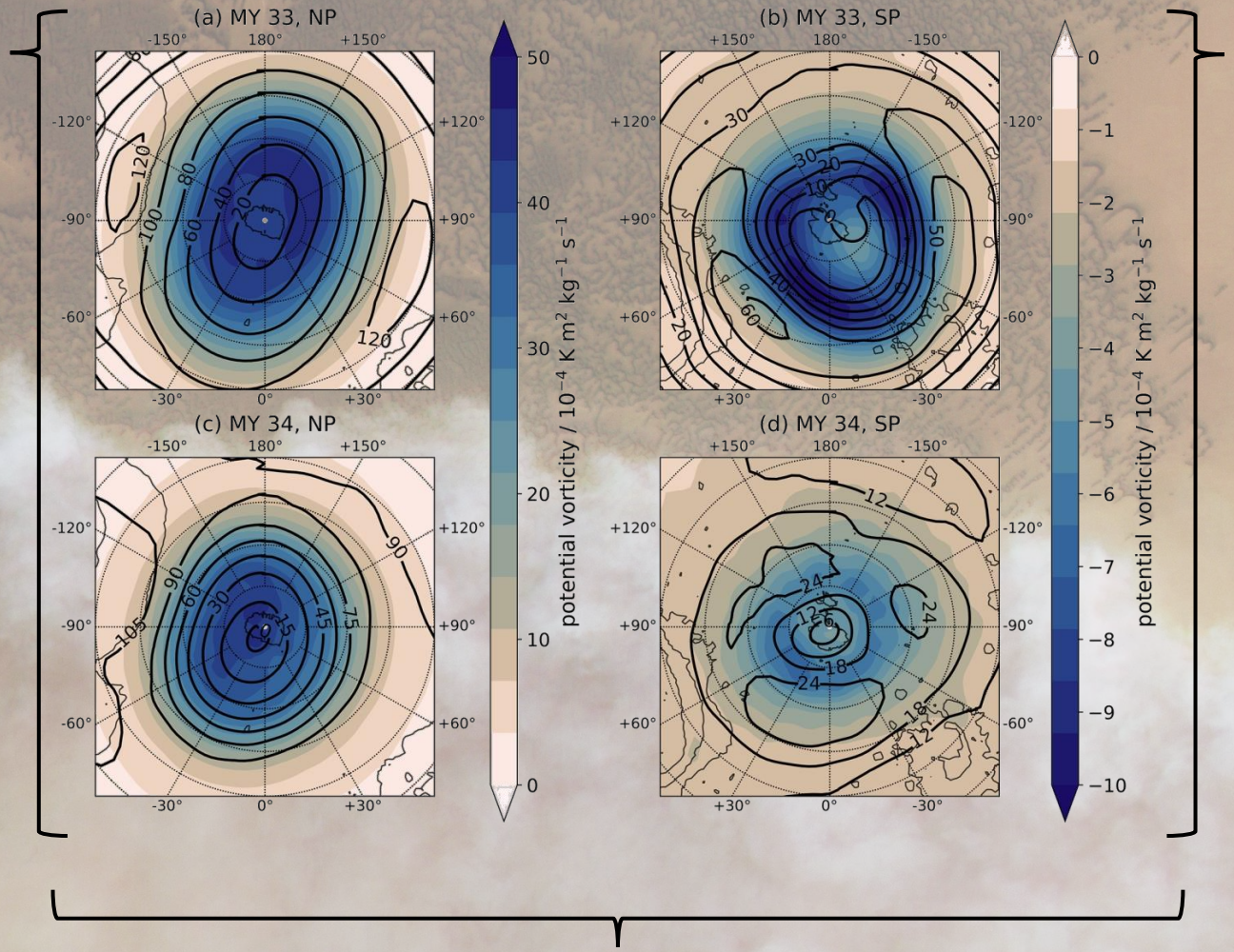
What?

Clear

North

- More symmetrical polar vortex shape; non-elliptical
- Reduced area
- Similar intensity
- Narrowed westerly jet



South

- More symmetrical polar vortex shape; non-elliptical
- Substantial local reduction in potential vorticity
- Significantly weakened winds

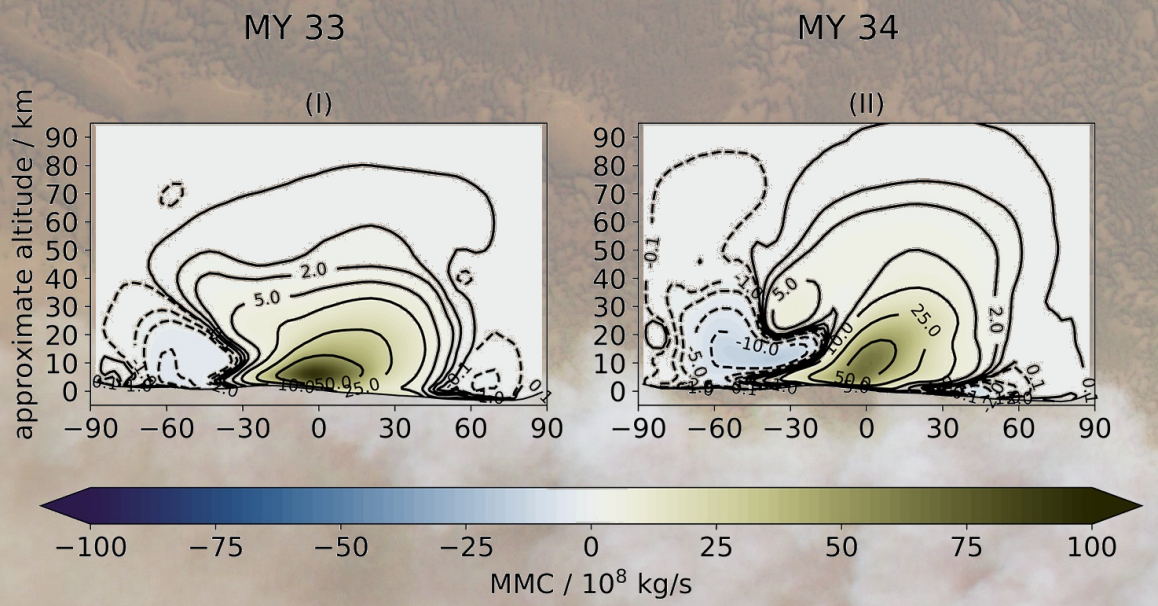
Why?

Why?

Storm

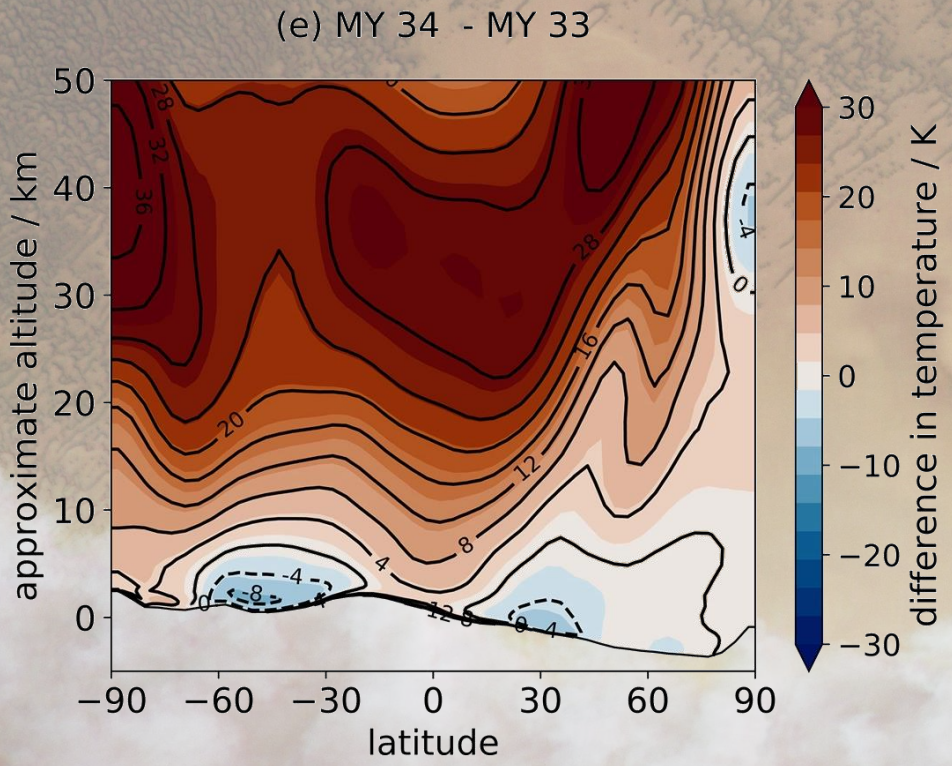
Why?

North



- Boosted meridional circulation…
- …but limited diabatic (dust) heating

South

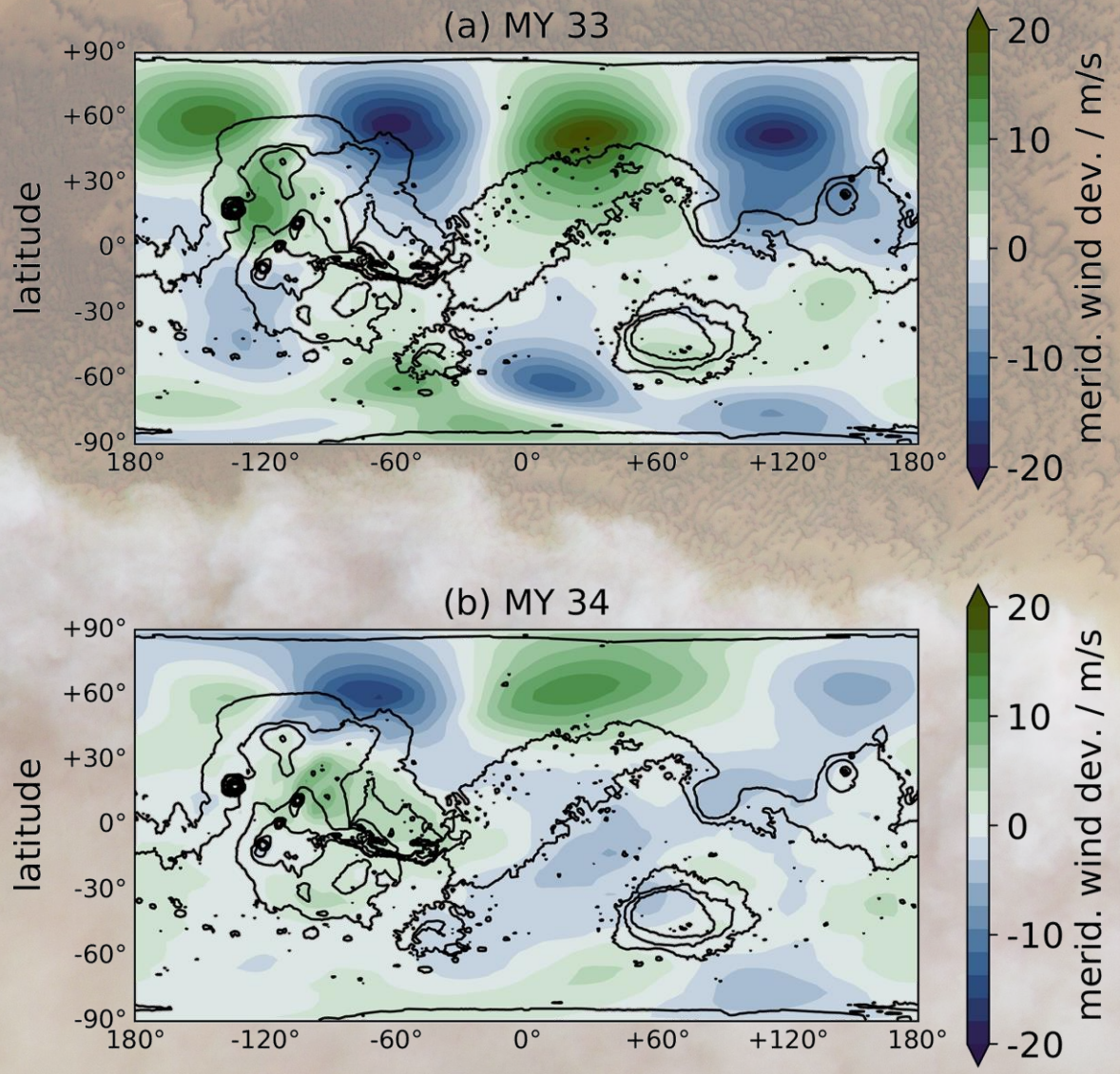


- High diabatic (dust heating) of the atmosphere
- Vortex already decaying (season)

Background: ESA/DLR/FU Berlin

What about shape?

- Plots of meridional wind deviation
- Reveals presence of stationary planetary waves: atmospheric waves with fixed position



- Stationary wave amplitude corresponds to decreased ellipticity of the polar vortices
- → Topography anchors polar vortex morphology

Background: ESA/DLR/FU Berlin